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RASCAL

Good Afternoon. I'm here to tell you about the RASCAL Program.

Pardon me for a few minutes, as I take you into the future. The year is 2009. The United States is now in the second year of a war against the Quadrature of Evil. The "Quad," as the media calls them, has been quiet since its attempt to detonate a nuclear weapon in the streets of San Francisco just a month ago.

Recently, the eyes of the nation's intelligence agencies have focused on a small patch of frozen tundra isolated by ancient steppes. It is here that sporadic information from sources indicates that the Quad is making preparations for its next attack with a little understood weapon of mass destruction.

Satellite coverage of the area is running at about 8 percent, with a 1-hour gap that is causing a great deal of uncertainty. Tonight, information suddenly indicates that the Quad is only about 12 hours from its first, and only test, of its new weapon. After making a quick call to the intelligence director, the duty officer dispatches the well-rehearsed order over the wide area defense network: "Launch the ready alert RASCALs."

The scene now shifts to Rumsfeld Air Force Base in the southeastern United States. From her office, the base commander, Col Cathy Dyer, hears the roar of four RASCAL launch vehicle jets taking off and thinks, "We will know more soon". Minutes later, the 4 jets go "feet wet" over the Atlantic Ocean. After a cruise period of 30 minutes, the planes enter a racetrack holding pattern at 35,000 feet, some 250 nautical miles from their home airfield. Only one of the RASCAL vehicles is manned.

The pilot onboard that manned version, Maj Albert Reynolds, reports "RASCAL 4-Mike, holding at angels 35, all systems go." Thereafter come identical reports from the three ground-based RASCAL operators.

In the lone manned RASCAL jet, Maj Reynolds thinks, "Such a shame"—not for the three ground RASCAL operators, but for me. In a month, his plane—the last of the manned RASCAL versions—will go to depot and the pilot's seat will be removed.

Maj Reynolds reminisces for a brief moment, recalling that first-ever RASCAL test flight he piloted, only 3 years ago. It was late 2006, putting him in the same ranks as Scott Crossfield, first pilot of the X-15. Thirty minutes have now passed since the lead RASCAL jet entered its loiter. Suddenly, all four pilots are refocused by the command center.

"RASCAL 4-Mike, confirm new mission update received."

Maj Reynolds replies, "Roger that, new inclination received and orbit insertion conditions have been modified."

Seconds later the command center orders "RASCAL 1-Uniform, you are a 'go' for zoom."

Now we focus inside the command center. There, from the comfort of his RASCAL workstation, Capt Harrison Marsh acknowledges the order. Tonight, Capt Marsh is controlling his tenth mission this year. Not a bad pace, he thinks.

Considering RASCAL now flies at least 20 times per year, Harrison believes he should be able to control another RASCAL flight or two before he detaches and transfers to his dream job in Arlington, Virginia, as a DARPA Program Manager.

After receiving the "go for zoom" command, the built-In test subsystem onboard each RASCAL autonomously completes a health diagnostic of the aircraft, the expendable rocket vehicle and the satellite payload, all in less than 1 minute.

Capt March selects the "Accept Zoom" command at his workstation, and the vehicle begins to accelerate. As the plane begins its climb, the MIPIC subsystem comes to life. MIPIC stands for mass injection precompressor cooling. A fine mist of water is being injected into the air ahead of the inlet of the vehicle's turbojet engine. This system is doing two things: it is cooling the compressor of the engine, preventing it from overheating as the plane goes faster and faster; and, by cooling the air, it is making it more dense, which actually increases the thrust of the engines. This allows conventional turbojet engine to accelerate the vehicle to higher and faster flight conditions than normally possible.

RASCAL 1 - Uniform continues its upward zoom, passing through Mach 2 and Mach 3. At 100,000 feet and Mach 4.0, the MIPIC subsystem continues to operate, now injecting liquid oxygen to compensate for the thin atmosphere and to maintain high thrust. As the plane exits the atmosphere, the plane's reaction control system begins to operate. At this point, the jet engines throttle back and shut down as prescribed.

At 150,000 feet, the workstation provides notification that the zoom target conditions have been met and the payload remains in excellent health as the craft coasts upwards. The pilot authorizes the staging of the ERV, or expendable rocket vehicle.

The RASCAL 1 – Uniform’s rocket bay doors open, exposing for the first time the rocket and satellite payload to the outside environment. They are softly ejected from the bay to continue their journey to orbit.

The RASCAL ERV is the Apollo "Lunar Excursion Module" of its day. A pure space vehicle, it is not designed to fly in the atmosphere. Above 200,000 feet, there's not much of an atmosphere. At this flight condition, the ERV is experiencing a total dynamic pressure of about 1 pound per square foot. That's about the same pressure you'd experience yourself while peddling your bike in low gear, at about 5 miles per hour. So, in effect, there's little need for fancy aerodynamic surfaces on the rocket.

The ERV is the subsystem that has the highest recurring cost per launch. By using low-cost rocket technology and taking advantage of its exo-atmospheric flight regime, the recurring cost of a RASCAL launch is kept low. The ERV has two stages. After each stage burns out, they eventually fall back to Earth and are not recovered. There is a small maneuvering module carrying the payload for final orbit insert and trim.

While the ERV and payload accelerate to orbit, each RASCAL airplane falls back into the atmosphere. The plane maintains a high angle of attack as it returns to avoid reentry heating and as it decelerates. At Mach 4, the reentry into the atmosphere is not as dramatic as reentry from space, but the flight techniques are much the same. Once the vehicle decelerates below Mach 1, the engines are restarted and the flight back to the base is begun.

One by one, the other RASCAL vehicles launch their payloads. The planes safely reenter the atmosphere, restart their engines, and head for Rumsfeld Airfield.

Col Dyer, is driving to the command center as she hear the jets coming home. When back on the ground, the planes will head for the hanger where they'll be prepared within 24 hours for a new mission.

Now, in orbit, four small measurement and signal intelligence microsatellites begin the collection and transmission of critical data for the intelligence directorate. At dawn the next morning, Col Dyer sees off four B-2s, each loaded with a bay full of precision targeted ordnance, on their way to give a little surprise to the Quadrature of Evil while they test their weapon on the tundra.

This marks the end to my journey into the future and my attempt to be the next Tom Clancy. The people and places discussed in the last few minutes are make believe, of course—although I will submit that I am a lot like Capt Marsh and believe that being a DARPA program manager is a dream job.

My name is Preston Carter and I am the Program Manager for RASCAL. In my little novel, the people and places are make believe, but the specific technological details of the operation are the objective of DARPA's RASCAL program.

RASCAL—which stands for Responsive Access, Small Cargo, Affordable Launch—is a space program started this year. The system architecture and concept of operations are exactly those painted by my journey into the future. Our goal at DARPA is to create a launch system capable of placing payloads up to 130 kg in low earth orbits. By properly balancing the requirements between reusable and expendable portions of the vehicles, maintaining low operating costs, and easing payload interface requirements, we hope to achieve a launch cost of $750,000, assuming a flight rate of 20 launches per year.

RASCAL will provide two unique capabilities: dedicated launch of small payloads and responsive access to space. RASCAL will demonstrate and explore many other technological frontiers, including:

* Highly operational, reusable launch vehicles
* Trans-atmospheric flight
* High mach number and accelerator turbojet propulsion
* Low-cost expendable launch vehicles
* Adaptive launch operations
* Vibration isolated payload interfaces

Since there are significant applications in both commercial and military sectors, DARPA is using Other Transaction agreements with its industry partners.

The RASCAL Program is being executed in three phases: a system study phase, a design phase, and the final build-and-flight phase.

This spring, DARPA selected six performers to begin the Phase 1 system studies. This phase will be 9 months long with a spiral downselect at the end to two partners who will continue to Phase 2.

Phase 2 is a 12-month design phase that will carry the performers through preliminary and critical design efforts.

The final spiral downselect to a single winning design will begin Phase 3, the construction, test, and demonstration of the RASCAL system.

Flight tests will begin in fiscal year 2005 with final system demonstrations in fiscal year 2006.

The six Phase I performers are:

* Northrop Grumman
* Coleman Research Corporation
* Pioneer Rocketplane
* Delta-Velocity
* Space Access
* Space Launch Corporation

In addition to the six RASCAL performers, DARPA has five small companies working on MIPCC turbojet technology. Later this year, these teams will demonstrate full-scale turbojet engines in MIPCC mode operating at critical flight conditions, including Mach 3 at 100,000 feet altitude.

DARPA has a long history of launch vehicle development. One of DARPA's first programs was the Saturn V launch vehicle, which was later transfer to NASA for the Apollo Program. In the late 80s we developed the Pegasus launch system, followed by the Taurus launcher in the 1990s.

The RASCAL Program hopes to continue DARPA's leadership in the advancement of launch vehicle development.

Thank you.